What is claimed is:

1. An optical device comprising:

a first optical portion made of a first optical material and having a concavity ; and

a second optical portion comprising a second optical material having a refractive index different from that of the first optical material, and inserted into the concavity.

2. An optical device as set forth in claim 1,

wherein the first optical portion has a first flat surface located at an area around a circumferential edge of the concavity, and a second flat surface substantially parallel to the first flat surface,

wherein the second optical material comprises a liquid-like optical material and is filled in the concavity; and

further comprising a layer made of an optical material for sealing the concavity filled with the second optical material on the first flat surface of the first optical portion from which the concavity is formed.

3. An optical device as set forth in claim 2, wherein the second optical portion comprises an optical oil or a liquid crystal.

4. An optical device as set forth in claim 2, wherein the concavity has a substantially rotationally

symmetric shape with reset to an optical axis, and the shape of the surface of the concavity when the concavity is cut along its symmetry axis is an arc or an substantially arc.

5. An optical device as set forth in claim 1, wherein a refractive index of said first optical material is between 1.3 and 1.9.

6. An optical device as set forth in claim 1, wherein the refractive index of said second optical material is between 1.4 and 4.0.

7. An optical device as set forth in claim 5, wherein the first optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

8. An optical device as set forth in claim 6, wherein the second optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

9. An optical system comprising first and second optical devices,

the first optical device having

a first optical portion made of a first optical material and having a first concavity and

a second optical portion comprising a second optical material having a refractive index different from that of the first optical material and inserted into the first concavity, and

the first concavity having a substantially rotationally symmetric shape with respect to an optical axis,

the second optical device having

a third optical portion made of a third optical material and having a second concavity and

a fourth optical portion comprising a fourth optical material having a refractive index different from that of the third optical material and inserted into the second concavity, and

the second concavity having a substantially rotationally symmetric shape with respect to the optical axis,

the first and second optical devices being bonded so that symmetry axes of the first and second concavities meet the optical axis.

10. An optical system as set forth in claim 9, wherein;

the first optical portion has a first flat

surface located at the area around the circumferential edge of the concavity and a second flat surface substantially parallel with respect to the first flat surface,

the outer surface of the second optical portion inserted in the first concavity and the second flat surface are located in an substantially identical plane,

the third optical portion has a third flat surface located at the area around the circumferential edge of the second concavity and a fourth flat surface substantially parallel with respect to the fourth flat surface, and

one of the first and second flat surfaces is bonded with the third flat surface.

11. An optical system as set forth in claim 10, wherein;

the first concavity is larger than the second concavity,

the second flat surface of the first optical portion and the third flat surface of the third optical portion are bonded,

the second optical material has a refractive index greater than that of the first optical material,

the fourth optical material has a refractive index greater than that of the third optical material,

to thereby form a solid immersion lens comprising the second optical material filled in the first concavity and the fourth optical material filled in the second concavity.

12. An optical system as set forth in claim 11, wherein the refractive indexes of said first optical material and said third optical material are between 1.3 and 1.9.

13. An optical system as set forth in claim 11, wherein the refractive indexes of said second optical material and said fourth optical material are between 1.4 and 4.0.

14. An optical system as set forth in claim 12, wherein the first optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

15. An optical system as set forth in claim 13, wherein the second optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

16. An optical system as set forth in claim 12,

wherein, the third optical material comprises aluminum oxide.

17. An optical system as set forth in claim 9, comprising a slider of an optical head attached to a swing arm.

18. An optical system as set forth in claim 9, further comprising a lens,

the lens being shaped by a substantially rotationally symmetric curved surface and the flat surface, and

the lens and the optical device being bonded so that the symmetry axis of the concavity and an optical axis of the lens meet an optical axis.

19. A method of production of an optical device comprising a first optical portion made of a first optical material and having a concavity and a second optical portion comprising a second optical material having a refractive index different from that of the first optical material, and inserted into the concavity, including:

a step of injecting the first optical material into a metallic mold formed with a projection projecting out into a cavity to form the first optical portion made of the first optical material with a concavity reproducing the shape of the projection; and

a step of filling the second optical portion in the concavity of the molded.

20. A method of production of an optical device as set forth in claim 19, further comprising a step of flattening the surface of the second optical portion filled in the concavity.

21. A method of production of an optical device as set forth in claim 20, wherein;

the projection of the first optical portion has a substantially rotationally symmetric shape with respect to an optical axis, and the section of shape of the surface of the projection is an substantially arc, and

in the flattening step, the surface of the second optical portion is polished so that a flat plane substantially vertical with respect to the symmetry axis of the concavity reproducing the shape of the projection is formed.

22. A method of production of an optical device as set forth in claim 21, further comprising a step of polishing the first optical portion so that a flat surface substantially parallel to the surface of the flattened second optical portion is formed.

23. A method of production of an optical device as set forth in claim 19, the first optical material comprises titanium oxide, tantalum oxide, gallium

phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

24. A method of production of an optical device as set forth in claim 18, the second optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

25. A method of production of an optical device comprising a first optical portion made of a first optical material and having a concavity and a second optical portion comprising a second optical material having a refractive index different from that of the first optical material, and inserted into the concavity, including:

a step of forming a resist having a hole in the flat surface of the first optical portion made of the first optical material;

a step of forming a concavity corresponding to the hole in the first optical portion by etching;

a step of removing a resist from the first optical portion with the concavity formed therein; and

a step of filling the second optical portion in the concavity of the first optical portion from which the

resist is removed.

26. A method of production of an optical device as set forth in claim 25, further comprising a step of flattening the surface of the second optical portion filled in the concavity.

27. A method of production of an optical device as set forth in claim 26, wherein;

the hole is substantially circular,

the concavity has a substantially rotationally symmetric shape, and

in the flattening step, the surface of the second optical portion is polished so that a flat surface substantially vertical with respect to the symmetry axis of the concavity is formed.

28. A method of production of an optical device as set forth in claim 26, further comprising a step of polishing the first optical portion so that a flat surface substantially parallel with respect to the surface of the flattened second optical portion is formed.

29. A method of production of an optical device as set forth in claim 25, wherein;

the hole is substantially circular,

the concavity has a substantially rotationally symmetric shape, and

the shape of the surface of the concavity in the case when the concavity is cut along its symmetry axis is an substantially arc.

30. A method of production of an optical device as set forth in claim 25, wherein the first optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

31. A method of production of an optical device as set forth in claim 25, wherein the second optical material comprises titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

32. A method of production of an optical device as set forth in claim 25, wherein the step of filling the second optical portion has

a step of filling the second optical portion in the concavity of the first optical portion from which the resist is removed and

a step of sealing the concavity filled with the second optical portion by a layer made of an optical material.

33. A method of production of an optical device as

set forth in claim 32, wherein;

the layer for sealing the concavity is formed by a film having a substantially constant thickness, and

the second optical portion is an optical oil or liquid crystal.

34. A method of production of an optical device comprising a first optical portion made of a first optical material and having a concavity and a second optical portion comprising a second optical material having a refractive index different from that of the first optical material, and inserted into the concavity, including:

a step of forming on a third optical portion provided with a projection and having a flat area around the projection the first optical portion made of a layer of the first optical material burying the projection,

a step of flattening the surface of the first optical portion to form a flat surface and bonding the related flat surface to a third base material made of a third optical material,

a step of removing the third optical portion from the first optical portion bonded to the third base material to expose the concavity reproducing the shape of the projection in the first optical portion, and

a step of filling the second optical portion in

the concavity of the exposed first optical portion.

35. A method of production of an optical device as set forth in claim 34, further comprising a step of flattening the surface of the second optical portion filled in the concavity.

36. A method of production of an optical device as set forth in claim 35, wherein

the projection has a substantially rotationally symmetric shape, and

in the flattening step, the surface of the second optical portion is polished so that a flat surface substantially vertical with respect to the symmetry axis of the concavity reproducing the shape of the projection is formed.

37. A method of production of an optical device as set forth in claim 35, further comprising a step of polishing the third base material so that a flat surface substantially parallel to the surface of the flattened second optical portion is formed.

38. A method of production of an optical device as set forth in claim 34, wherein;

the projection has a substantially rotationally symmetric shape, and

the shape of the surface of the projection when the projection is cut along its symmetry axis is an

substantially arc.

39. A method of production of an optical device as set forth in claim 34, wherein the first optical material and the third optical material are identical optical materials.

40. A method of production of an optical device as set forth in claim 34, wherein the second optical portion is titanium oxide, tantalum oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

41. A method of production of an optical device as set forth in claim 34, wherein;

the second optical portion is a liquid-like optical material, and

the step of filling the second optical portion has

a step of filling the second optical portion in the concavity of the exposed first optical portion and

a step of sealing the concavity filled with the second optical portion by a layer made of an optical material.

42. A method of production of an optical device as set forth in claim 41, wherein;

the layer for sealing the concavity is formed by a film having a substantially constant thickness, and

the second optical portion is an optical oil or liquid crystal.

43. A method for production of an optical device having a first optical portion made of a first optical material and having a concavity and a second optical portion comprising a second optical material having a refractive index different from that of the first optical material, and inserted into the concavity, comprising:

a step of forming resist films having windows on substantially flat first and second flat surfaces facing each other of a first optical portion made of the first optical material;

a step of forming concavities corresponding to the windows in the first and second flat surfaces of the first optical portion by etching;

a step of removing the resist films from the first optical portion with the concavities formed therein; and

a step of filling the second optical portion in the concavities of the first and second flat surfaces of the first optical portion from which the resist films have been removed.

44. A method of production of an optical device as

set forth in claim 43, further comprising a step of flattening the surface of the second optical portion filled in the concavities of the first and second flat surfaces.

45. A method of production of an optical device as set forth in claim 44, wherein

the windows are substantially circular,

the concavities have substantially rotationally symmetric shapes with respect to the optical axis, and

the flattening step has

a step of polishing the surface of the second optical portion filled in the concavity of the first flat surface so that a flat surface substantially vertical with respect to the symmetry axis of the concavity of the first flat surface is formed, and

a step of polishing the surface of the second optical portion filled in the concavity of the second flat surface so that a flat surface substantially vertical with respect to the symmetry axis of the concavity of the second flat surface is formed.

46. A method of production of an optical device as set forth in claim 43, wherein;

the second optical portion is a liquid-like optical material, and

the step of filling the second optical portion

has a step of filling the second optical portion in the concavity of the first face of the first optical portion with the resist film removed therefrom and sealing the concavity of the related first face by a first layer made of the optical material and then filling the second optical portion in the concavity of the second face and sealing the concavity of the related second face by a second layer made of the optical material.

47. A method of production of an optical device as set forth in claim 46, wherein the second optical portion is an optical oil or liquid crystal.

48. A method for production of an optical device a first optical portion made of a first optical material and having a concavity and a second optical portion comprising a second optical material having a refractive index different from that of the first optical material, and inserted into the concavity, comprising:

a step of forming on a third optical portion provided with a first projection and having a flat area around the first projection a first optical portion made of a layer of the first optical material burying the first projection;

a step of forming on a fourth optical portion provided with a second projection and having a flat area around the second projection a third optical portion made

of a layer of the first optical material burying the second projection;

a step of flattening the surface of the first optical portion to form a flat surface and bonding the related flat surface to a first flat surface among facing first and second flat surfaces of a fifth optical portion made of a third optical material;

a step of flattening the surface of the third optical portion to form a flat surface and bonding the related flat surface to the second flat surface of the fifth optical portion;

a step of removing the second and fourth optical portions from the first and third optical portions bonded to the fifth optical portion and exposing concavities with the shapes of the first and second projections transferred thereto in the first and third optical portions; and

a step of filling the second optical portion in the concavities of the exposed first and third optical portions.

49. A method of production of an optical device as set forth in claim 48, further comprising a step of flattening the surface of the second optical portion filled in the concavities of the first and third optical portions.

50. A method of production of an optical device as set forth in claim 49, wherein;

the first and second projections have substantially rotationally symmetric shapes with respect to the optical axis, and

the flattening step has

a step of polishing the surface of the second optical portion filled in the concavity of the first optical portion so that a flat surface substantially vertical with respect to the symmetry axis of the concavity of the first optical portion with the shape of the first projection transferred thereto is formed and

a step of polishing the surface of the second optical portion filled in the concavity of the third optical portion so that a flat surface substantially vertical with respect to the symmetry axis of the concavity of the third optical portion with the shape of the second projection transferred thereto is formed.

51. A method of production of an optical device as set forth in claim 50, wherein

the second optical portion is a liquid-like optical material, and

the step of filling the second optical portion

has a step of filling the second optical portion in the concavity of the exposed first optical portion and sealing the concavity of the related first optical portion by a first layer made of the optical material and then filling the second optical portion in the concavity of the third optical portion and sealing the concavity of the related third optical portion by a second layer made of the optical material.

52. An optical device, comprising:

a convex lens formed with a convex curved face; and

a first optical portion closely contacting the convex curved face of the convex lens, wherein;

the first optical portion has first and second faces facing each other, a concave curved face closely contacting the convex curved face being formed in the first face, and a hole communicating with the second face being formed from a deep side of the concave curved face, and

part of the convex curved face of the convex lens is exposed in the hole of the first optical portion.

53. An optical device as set forth in claim 52, wherein;

the convex lens has a rotationally symmetric or substantially rotationally symmetric shape surrounded or

substantially surrounded by a flat surface and the convex curved face facing this flat surface, and

an optical axis of the convex lens or an extension thereof passes through the hole.

54. An optical device as set forth in claim 53, wherein the area around the concave curved face in the first face of the first optical portion is substantially flat and substantially parallel to the flat surface of the convex lens.

55. An optical device as set forth in claim 54, wherein the area around the concave curved face in the first face of the first optical portion is flat or substantially flat and located in an identical plane or substantially identical plane

56. An optical device as set forth in claim 53, wherein;

the hole has a rotationally symmetric or substantially rotationally symmetric shape,

the rotational symmetry axis of the hole and the optical axis of the convex lens coincide or substantially coincide, and

the concave curved face forms an annular inclined face.

57. An optical device as set forth in claim 53, wherein the material of the convex lens can be made

titanium oxide, tantalum oxide, niobium oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

58. An optical system comprising first and second optical devices, wherein;

the first optical device has a first convex lens formed with a convex curved face and a first optical portion with the convex curved face of the first convex lens bonded thereto;

the first optical portion has first and second faces facing each other, a concave curved face closely contacting the convex curved face being formed in the first face, and a hole communicating with the second face being formed from a deep side of the concave curved face;

part of the convex curved face of the first convex lens is exposed in the first hole of the first optical portion;

the second optical device has a second convex lens with the convex curved face formed thereon and a third optical portion with the convex curved face of the second convex lens bonded thereto; and

the third optical portion has third and fourth faces facing each other, a concave curved face closely contacting the convex curved face of the second convex

lens being formed in the third face, and the first and second optical devices being bonded so that the optical axes of the first and second convex lenses coincide or substantially coincide.

59. An optical system as set forth in claim 58, wherein;

the first convex lens has a rotationally symmetric or substantially rotationally symmetric shape surrounded by the flat surface and the convex curved face facing this flat surface, and

the optical axis of the first convex lens or the extension thereof passes through the first hole.

60. An optical system as set forth in claim 59, wherein;

the second face of the first optical portion is flat or substantially flat and parallel or substantially parallel to the flat surface of the first convex curved face, and

the area around the concave curved face in the first face of the first optical portion is flat or substantially flat and parallel or substantially parallel to the flat surface of the first convex lens.

61. An optical system as set forth in claim 59, wherein;

the second face of the first optical portion is

substantially flat and substantially parallel to the flat surface of the first convex curved face, and

the area around the concave curved face in the first face of the first optical portion is flat or substantially flat and located in the identical plane or substantially identical plane to the flat surface of the first convex lens.

62. An optical system as set forth in claim 59, wherein;

the first hole has a substantially rotationally symmetric shape with respect to the optical axis,

the rotational symmetry axis of the first hole and the optical axis of the first convex lens coincide or substantially coincide, and

the concave curved face of the first optical portion forms an annular inclined face.

63. An optical system as set forth in claim 62, wherein;

in the third optical portion, a second hole communicating with the fourth face is formed from the deep side of the concave curved face closely contacting the convex curved face of the second convex lens, and

part of the convex curved face of the second convex lens is exposed in the second hole of the third optical portion.

64. An optical system as set forth in claim 63, wherein;

the second convex lens has a rotationally symmetric or substantially rotationally symmetric shape surrounded by the flat surface and the convex curved face facing this flat surface, and

the optical axis of the second convex lens or the extension thereof passes through the second hole.

65. An optical system as set forth in claim 64, wherein;

the fourth face of the third optical portion is flat or substantially flat and parallel or substantially parallel to the flat surface of the second convex curved face, and

the area around the concave curved face in the third face of the third optical portion is flat or substantially flat and parallel or substantially parallel to the flat surface of the second convex lens.

66. An optical system as set forth in claim 64, wherein;

the fourth face of the third optical portion is flat or substantially flat and parallel or substantially parallel to the flat surface of the second convex curved face, and

the area around the concave curved face in the

third face of the third optical portion is flat or substantially flat and located in the identical plane or substantially identical plane to the flat surface of the second convex lens.

67. An optical system as set forth in claim 66, wherein;

the second hole has a rotationally symmetric or substantially rotationally symmetric shape with respect to the optical axis,

the rotational symmetry axis of the second hole and the optical axis of the second convex lens coincide or substantially coincide, and

the concave curved face of the third optical portion forms an annular inclined face.

68. An optical system as set forth in claim 66, wherein the material of the first and/or second convex lens is titanium oxide, tantalum oxide, niobium oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

69. An optical system as set forth in claim 66, wherein;

the first convex lens is larger than the second convex lens,

the first face of the first optical portion and

the fourth face of the third optical portion are bonded, and

a solid immersion lens is comprised by the first and second optical devices.

70. An optical system as set forth in claim 66, wherein the material of the third optical portion is aluminum oxide or silicon oxide.

71. A method for production of an optical device having a convex lens and a first optical portion closely contacting the convex curved face of this convex lens, comprising:

a step of using a metallic mold formed with a projection projecting out into a cavity to mold a first optical portion formed with a concavity reproducing the shape of the projection;

a step of filling an optical material in the concavity of the molded optical portion;

a step of flattening the surface of the optical material filled in the concavity to form the convex lens; and

a step of forming a hole so that part of the convex curved face closely contacting the concavity in the convex lens is exposed in the first optical portion.

72. A method of production of an optical device as

set forth in claim 71, further comprising a step of polishing the first optical portion so that a flat surface parallel or substantially parallel with respect to the surface of the flattened optical material is formed.

73. A method of production of an optical device as set forth in claim 73, wherein the step of forming the hole in the first optical portion has

a step of forming a resist film having a window on the flat surface of the first optical portion formed in the step of polishing the first optical portion,

a step of forming a hole corresponding to the window in the first optical portion by etching, and

a step of removing the resist film from the first optical portion.

74. A method of production of an optical device as set forth in claim 73, wherein the window has a circular or substantially circular shape.

75. A method of production of an optical device as set forth in claim 73, wherein

the step of filling the optical material has

a step of forming a coating film covering the surface of the concavity of the mold optical portion and

a step of filling a optical material in

the concavity formed with the coating film,

the step of forming the hole in the first optical portion has

a step of forming a resist film having a window on the flat surface of the first optical portion formed in the step of polishing the first optical portion,

a step of forming a hole reaching the coating film from the window in the first optical portion by etching,

a step of removing the resist film from the first optical portion formed with the hole, and

a step of removing the part of the coating film exposed in the hole.

76. A method of production of an optical device as set forth in claim 77, wherein the window has a circular or substantially circular shape.

77. A method of production of an optical device as set forth in claim 72, wherein

the projection has a rotationally symmetric or substantially rotationally symmetric shape, and

in the step of forming the convex lens, the surface of the optical material is polished so that a flat surface vertical or substantially vertical with respect to the symmetry axis of the concavity with the

shape of the projection transferred thereto is formed.

78. A method of production of an optical device as set forth in claim 77, wherein the shape of the surface of the projection when the projection is cut along its symmetry axis is an arc or substantially arc.

79. A method of production of an optical device as set forth in claim 71, wherein the optical material is titanium oxide, tantalum oxide, niobium oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

80. A method for production of an optical device having a convex lens and a first optical portion closely contacting the convex curved face of this convex lens, comprising:

a step of forming a first resist film having a first window in the flat surface of the first optical portion;

a step of forming a concavity corresponding to the first window in the first optical portion by etching;

a step of removing the first resist film from the first optical portion formed with the concavity;

a step of filling an optical material in the concavity of the first optical portion from which the first resist film is removed;

a step of flattening the surface of the optical material filled in the concavity to form the convex lens; and

a step of forming a hole whereby part of the convex curved face closely contacting the concavity in the convex lens is exposed in the first optical portion.

81. A method of production of an optical device as set forth in claim 80, further comprising a step of polishing the first optical portion so that a flat surface parallel or substantially parallel with respect to the surface of the flattened optical material is formed.

82. A method of production of an optical device as set forth in claim 81, wherein the step of forming the hole in the first optical portion has

a step of forming a second resist film having a second window in the flat surface of the first optical portion formed in the step of polishing the first optical portion,

a step of forming a hole corresponding to the second window in the first optical portion by etching, and

a step of removing the second resist film from the first optical portion formed with the hole.

83. A method of production of an optical device as

set forth in claim 82, wherein the second window has a circular or substantially circular shape.

84. A method of production of an optical device as set forth in claim 81, wherein

the step of filling the optical material has

a step of forming a coating film covering the surface of the concavity of the first optical portion from which the first resist film has been removed and

a step of filling an optical material in the concavity formed with the coating film, and

the step of forming the hole in the first optical portion has

a step of forming a second resist film having a second window in the flat surface of the first optical portion formed in the step of polishing the first optical portion,

a step of forming a hole reaching the coating film from the second window in the first optical portion by etching,

a step of removing the second resist film from the first optical portion formed with the hole, and

a step of removing a part exposed in the hole in the coating film.

85. A method of production of an optical device as set forth in claim 84, wherein the second window has a

circular or substantially circular shape.

86. A method of production of an optical device as set forth in claim 80, wherein

the first window is circular or substantially circular,

the concavity has a rotationally symmetric or substantially rotationally symmetric shape, and

in the step of forming the convex lens, the surface of the optical material is polished so that a flat surface vertical or substantially vertical with respect to the symmetry axis of the concavity is formed.

87. A method of production of an optical device as set forth in claim 86, wherein the shape of the surface of the concavity when the concavity is cut along its symmetry axis is an arc or substantially arc.

88. A method of production of an optical device as set forth in claim 80, wherein the optical material is titanium oxide, tantalum oxide, niobium oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

89. A method for production of an optical device having a convex lens and a first optical portion closely contacting the convex curved face of this convex lens, comprising:

a step of forming on a third optical portion provided with a projection and having a flat area around the projection a first optical portion made of a layer burying the projection;

a step of flattening the surface of the first optical portion to form a flat surface and bonding the related flat surface to a third optical portion;

a step of removing the third optical portion from the first optical portion bonded to the third optical portion to expose the concavity with the shape of the projection transferred thereto in the first optical portion;

a step of filling an optical material in the exposed concavity of the first optical portion;

a step of flattening the surface of the optical material filled in the concavity to form the convex lens; and

a step of forming holes whereby part of the convex curved face closely contacting the concavity in the convex lens is exposed in the first and third optical portions.

90. A method of production of an optical device as set forth in claim 89, further comprising a step of polishing the third optical portion so that a flat surface parallel or substantially parallel with respect

to the surface of the flattened optical material is formed.

91. A method of production of an optical device as set forth in claim 90, wherein

the step of forming the holes in the first and third optical portions has

a step of forming a resist film having a window in the flat surface of the third optical portion formed in the step of polishing the third optical portion,

a step of forming holes corresponding to the windows in the first and third optical portions by etching, and

a step of removing the resist films from the first and third optical portions formed with the holes formed.

92. A method of production of an optical device as set forth in claim 91, wherein the windows have circular or substantially circular shapes.

93. A method of production of an optical device as set forth in claim 90, wherein

the step of filling the optical material has

a step of forming a coating film covering the surface of the exposed concavity of the first optical portion and

a step of filling the optical material in the concavity formed with the coating film, and

the step of forming the hole in the first optical portion has

a step of forming a resist film having a window in the flat surface of the third optical portion formed in the step of polishing the third optical portion,

a step of forming holes reaching the coating film from the window in the first and third optical portions by etching,

a step of removing the resist films from the first and third optical portions formed with the holes formed, and a step of removing the part exposed in the hole in the coating film.

94. A method of production of an optical device as set forth in claim 93, wherein the windows have circular or substantially circular shapes.

95. A method of production of an optical device as set forth in claim 89, wherein

the projection has a rotationally symmetric or substantially rotationally symmetric shape, and

in the step of forming the convex lens, the surface of the optical material is polished so that a

flat surface vertical or substantially vertical with respect to the symmetry axis of the concavity with the shape of the projection transferred thereto is formed.

96. A method of production of an optical device as set forth in claim 95, wherein the shape of the surface of the projection when the projection is cut along its symmetry axis is an arc or substantially arc.

97. A method of production of an optical device as set forth in claim 89, wherein the first and third optical portions are made of an identical material.

98. A method of production of an optical device as set forth in claim 89, wherein the optical material is titanium oxide, tantalum oxide, niobium oxide, gallium phosphate, gallium nitride, a compound of titanium, niobium, and oxygen, a compound of titanium, tantalum, and oxygen, or silicon nitride.

99. An optical device obtained by forming a concavity by a pin in optical material in a molten state or softened state, hardening the optical material with the related concavity formed therein, and polishing or grinding a face where the concavity is formed so that a hole of a front end of the concavity remains in a first optical portion obtained thereby.

100. An optical device as set forth in claim 99, wherein the hole of the front end of the concavity has a

spherical or substantially spherical shape.

101. An optical device as set forth in claim 99, wherein;

the hardened optical material has first and second faces facing each other,

the concavity is formed in the first face, the area around the concavity is flat, and

the area around of the concavity in the first face and the second face are parallel or substantially parallel to each other.

102. An optical device as set forth in claim 101, wherein an optical material having a refractive index different from that of the first optical portion is filled in the concavity.

103. A metallic mold for production of an optical device made of an optical material, comprising

a cavity into which an optical material in a molten state or softened state is filled and

a pin for forming a concavity in the optical material in the molten state or softened state in the cavity,

wherein the pin projects out into the cavity while penetrating through a wall of the cavity from the outside.

104. A metallic mold for production of an optical

device as set forth in claim 103, wherein the hole of the front end of the concavity has a spherical or substantially spherical shape.

105. A metallic mold for production of an optical device as set forth in claim 103, wherein

the pin has a head and a projection projecting out from the head, and

the projection has

a rounded projecting front end,

a pole having a constant diameter, and

a taper located between the front end and the pole and having a shape flaring from the front end to the pole.

106. A metallic mold for production of an optical device as set forth in claim 103, wherein

the area around of the pin in the wall of the cavity is flat, and

the surface of the facing wall facing to the wall of the related cavity is flat.

107. A method for producing an optical device by using a metallic mold having a cavity into which an optical material in a molten state or softened state is to be filled and a pin for forming a concavity in the optical material in the molten state or softened state in the cavity, wherein the pin penetrates through the wall

of the cavity from the outside and projects out into the cavity, comprising:

a step of filling the optical material in the molten state or softened state in the cavity to create a first optical portion formed with the concavity by a simple molding; and

a step of polishing or grinding the face of the first optical portion where the concavity is formed so that a hole of a front end of the concavity remains.

108. A method of production of an optical device as set forth in claim 107, wherein the hole of the front end of the concavity has a spherical or substantially spherical shape.

109. A method for producing an optical device by using a metallic mold having a cavity into which an optical material in a molten state or softened state is to be filled and a pin for forming a concavity in the optical material in the molten state or softened state in the cavity, wherein the pin penetrates through the wall of the cavity from the outside and projects out into the cavity, comprising:

a step of filling the optical material in the molten state or softened state in the cavity to create a first optical portion formed with the concavity by simple molding;

a step of filling an optical material having a refractive index different from that of the first optical portion in the concavity of the first optical portion; and

a step of flattening the surface of the optical material filled in the concavity to form a convex lens made of the related optical material.

110. A method of production of an optical device as set forth in claim 109, further having a step of polishing or grinding the face of the first optical portion where the concavity is formed so that a hole of the front end of the concavity filled with the optical material having a different refractive index remains.

111. A method of production of an optical device as set forth in claim 109, wherein the hole of the front end of the concavity has a spherical or substantially spherical shape.

112. A method of production of an optical device, comprising:

a step of forming a concavity by a pin in an optical material in a molten state or softened state and

a step of polishing or grinding the face where the concavity is formed so that a hole of a front end of the concavity remains in a first optical portion obtained by hardening the optical material formed with the related

concavity.

113. A method of production of an optical device as set forth in claim 112, wherein the hole of the front end of the concavity has a spherical or substantially spherical shape.

114. A method of production of an optical device as set forth in claim 112, wherein the front end of the pin has a rounded projecting shape.